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Fuzzy Logic Based Video Quality Adaptation in Future Ready Smart Home

Heena Gupta[1], Richa Gupta[2]
[1]Computer Department, GCET, J&K, India
[2]MCA, Jammu University, J&K, India
Email address: heenagupta1.2011@gmail.com

Abstract— In smart home environment networking and collaboration based multimedia content sharing has become challenging issue. The advancement in technology has created the need of high bandwidth requirements. Due to the packet loss caused by network congestion, video quality degradation is a critical problem in the device collaboration services. Congestion control of a variable bit-rate video stream crossing the Internet is crucial to ensuring the quality of the received video. A fuzzy-logic congestion controller (FLC) changes the sending rate of a video transcoder, it does so without feedback of packet loss, using packet dispersion instead. The FLC's sending rate is significantly smoother, it avoids any risk of congestion collapse. The goal of the proposed system is to provide congestion control scheme based quality adaptation.

I. Introduction

1.1 Home Networks

A home network or home area network (HAN) is a type of local area network that develops from the need to facilitate communication and interoperability among digital devices present inside or within the close vicinity of a home. Devices capable of participating in this network–smart devices such as network printers and handheld mobile computers–often gain enhanced emergent capabilities through their ability to interact. These additional capabilities can then be used to increase the quality of life inside the home in a variety of ways, such as automation of repetitious tasks, increased personal productivity, enhanced home security, and easier access to entertainment.

1.2 Device Collaboration in Home Networks

Device Collaboration is to control a set of computing devices that are connected with communication network as if the devices are connected in a single computer. In a wirelessly-connected home network, the downloaded video streams are recorded in the storage space of a mobile device. Then, they are instantly shared with other mobile devices. The device collaboration service is also used to enable cooperation of the collaborative contents among consumer electronics and the mobile devices in multimedia streaming applications. This service has to provide content synchronization between the consumer electronics and mobile devices in distributed devices environments.

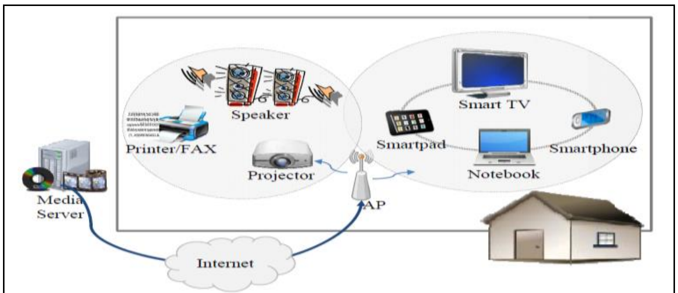

Fig. 1. An Example of Device Collaboration.

1.3 SVC (Scalable Video Coding)

Scalable video coding (SVC) is an extension of the H.264 (MPEG-4 AVC) video compression standard for video encoding .

The video codec allows video transmission to scale so that content is delivered without degradation between various endpoints -- for example, between a laptop and a mobile device. The SVC codec translates bit s from a network data stream into a picture and conversely translates camera video into a bit stream . It breaks up video bit streams into bit stream subsets that add layers of quality and resolution to video signals

SVC codecs adapt to sub-par network connections by dropping these bit stream subsets orpacket s in order to reduce theframe rate , resolution orbandwidth consumption of a picture, which prevents the picture from breaking up. For example, a mobile phone would receive only the base layer or bit stream while a high-definition video conferencing console would receive both the base layer and bit stream subset or enhancement layer.

SVC is backwards compatible, so an SVC codec can communicate with an H.264 codec that is not SVC-capable. A number of video conferencing equipment manufacturers embrace SVC encoding, including Avaya (Radvision), LifeSize, Polycom and Vidyo.

1.4 Fuzzy Expert System

A fuzzy expert system is an expert system that uses a collection of fuzzy membership functions and rules, instead of Boolean logic, to reason about data.

The rules in a fuzzy expert system are usually of a form similar to the following:

if x is low and y is high then z = medium

where x and y are input variables (names for know data values), z is an output variable (a name for a data value to be computed), low is a membership function (fuzzy subset) defined on x, high is a membership function defined on y, and medium is a membership function defined on z.

The antecedent (the rule's premise) describes to what degree the rule applies, while the conclusion (the rule's

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consequent) assigns a membership function to each of one or more output variables. Most tools for working with fuzzy expert systems allow more than one conclusion per rule. The set of rules in a fuzzy expert system is known as the rule base or knowledge base

The general inference process proceeds in three (or four) steps.

1. Under FUZZIFICATION, the membership functions defined on the input variables are applied to their actual values, to determine the degree of truth for each rule premise.
2. Under INFERENCE, the truth value for the premise of each rule is computed, and applied to the conclusion part of each rule. This result in one fuzzy subset to be assigned to each output variable for each rule. Usually only MIN or PRODUCT are used as inference rules. In MIN inferencing, the output membership function is clipped off at a height corresponding to the rule premise's computed degree of truth (fuzzy logic AND). In PRODUCT inferencing, the output membership function is scaled by the rule premise's computed degree of truth.
3. Under COMPOSITION, all of the fuzzy subsets assigned to each output variable are combined together to form a single fuzzy subset for each output variable. Again, usually MAX or SUM are used. In MAX composition, the combined output fuzzy subset is constructed by taking the pointwise maximum over all of the fuzzy subsets assigned to variable by the inference rule (fuzzy logic OR). In SUM composition, the combined output fuzzy subset is constructed by taking the pointwise sum over all of the fuzzy subsets assigned to the output variable by the inference rule.
4. Finally is the (optional) DEFUZZIFICATION, which is used when it is useful to convert the fuzzy output set to a crisp number. There are more defuzzification methods ,two of the more common techniques are the CENTROID and MAXIMUM methods. In the CENTROID method, the crisp value of the output variable is computed by finding the variable value of the center of gravity of the membership function for the fuzzy value. In the MAXIMUM method, one of the variable values at which the fuzzy subset has its maximum truth value is chosen as the crisp value for the output variable

II. LITERARTURE SURVEY

[3]This paper proposes mediaquality control scheme for a device collaboration service that determines collaboration contents according to the number ofavailable collaboration devices at home. It also adaptively controls the media quality based on available network bandwidth using estimated M-TFRC (Modified TCP-friendly Rate Control) rate. This scheme do not accurately estimate the available network bandwidth as it uses pair probing technique.

[13] This paper presents a new active probing tool for estimating the available bandwidth on a communication network path. Based on the concept of “self-induced congestion,” PathChirp features an exponential flight pattern of probes. By rapidly increasing the probing rate within each chirp, PathChirp obtains a rich set of information from which to dynamically estimate the available bandwidth. This technique involves the use of a predefined packet train for bandwidth estimation hence this technique involves computational delay in estimating the available bandwidth.

[5]The proposed scheme quickly adjusts the data transmission rate according to the estimated available bandwidth of network. It also controls media quality using SVC characteristics. Since bandwidth estimation involves sending train of packets to the congested network,thus this scheme suffers from packet loss problem.

[4] The focus of this paper is on the use of fuzzy logic for congestion avoidance and control of networked video, in combination of using delay as a network congestion level indicator, and packet loss as an indicator of full blown congestion. This scheme uses the media format which fails in saving bandwidth when the same media content is required to be sent simultaneously at different resolutions to support heterogeneous devices and networks

As per the literature surveyed so far , in home networks, seamless networking and collaborative streaming-based multimedia content sharing have become challenging issues in providing QoS (Quality of Service) for its users with heterogeneous consumer electronic devices. In order to support the demands for QoS, recently SVC (Scalable Video Coding) scheme has attracted attention. However, existing schemes do not guarantee the quality of multimedia contents and moreover these scheme are congestion avoidance schemes. Hence there is a need to develop a congestion control scheme based quality adaptation.

III. PROPOSED SYSTEM

The goal of the proposed system is to provide congestion control scheme based quality adaptation. For this purpose introduce the following two modules in the architecture:

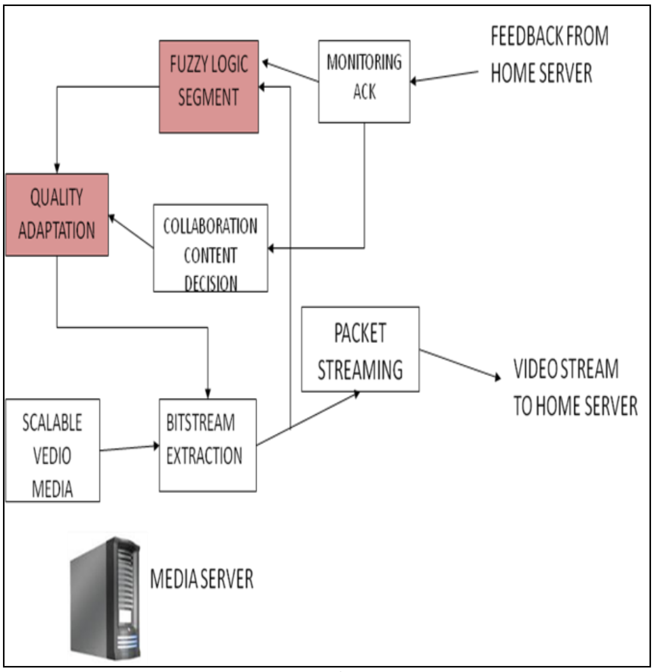

Fig. 2. Architecture of the proposed system.

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1. Fuzzy Logic segment:

This segment consist of the following units:

- Congestion level determination: The home server monitors the dispersion of incoming packets and relays this information to the congestion level determination (CLD) unit through feedback controller. The CLD unit monitors the outgoing packet stream, especially the packet sizes, and combines this information with feedback from the Home Server as a basis for determining the network congestion level, CL. This unit also computes the congestion-level rate of change, δCL.
- Fuzzifiers: convert the inputs CL and δCL into suitable linguistic variables.
- A knowledge base: encapsulates expert knowledge of the application with the required control goals. It defines the labels that help specify a set of linguistic rules.
- The Inference engine:block is the intelligence of the controller, with the capability of emulating the human decision making process, based on fuzzy logic, by means of the knowledge database and embedded rules for making those decisions.
- Defuzzification block converts the inferred fuzzy control decisions from the inference engine to a crisp value, which is converted to a control signal, CT

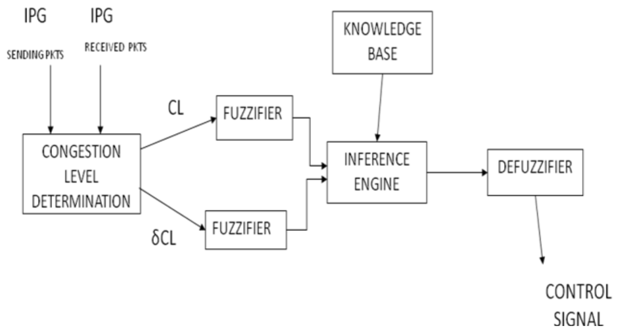

Fig. 3 Fuzzy logic control.

2. Quality Adaptation

This segment consist of the following tasks

It accepts the control signal as input from fuzzy logic set depending upon the value of the signal it changes the sending rate of video frames .The video format used is SVC. Users are usually more sensitive to the rapid quality variation than quality degradation. To smoothly adjust the quality as bandwidth changes, we propose a media quality adaptation scheme using the SVC encoding scheme. As the SVC provides an effective way such that a media server can coarsely adjust the quality of a video stream without transcoding the stored data. The media quality adaptation scheme consists of the adaptive layer distribution method and network-adaptive IDR (Instantaneous Decoder Refresh) period method. The video quality based on SVC encoding scheme is adjusted over long periods of time.

IV. Conclusion

In smart home environment networking and collaboration based multimedia content sharing has become challenging issue. The advancement in technology has created the need of high bandwidth requirements. The Due to the packet loss caused by network congestion, video quality degradation is a critical problem in the device collaboration services. Congestion control of a variable bit-rate video stream crossing the Internet is crucial to ensuring the quality of the received video. A fuzzy-logic congestion controller (FLC) changes the sending rate of a video transcoder , it does so without feedback of packet loss, using packet dispersion instead. The FLC's sending rate is significantly smoother, it avoids any risk of congestion collapse.

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